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## Claims

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- 5 1. A microorganism transformed with at least one recombinant DNA molecule encoding or otherwise causing the expression of at least one enzyme that causes the functional coupling of the oxidation and reduction of substrates by two pyridine nucleotide-linked dehydrogenase reactions with different specificities for the NAD/NADH and NADP/NADPH coenzyme couples and so facilitates the transfer of electrons between the two coenzyme couples through the said substrates, said transformed microorganism
- 10 thereby producing useful products more efficiently than a corresponding non-transformed microorganism.
2. The microorganism of claim 1, said microorganism producing more product per unit of raw material than does a corresponding non-transformed microorganism.
- 15 3. The microorganism of claim 1, said microorganism producing a product faster than does a corresponding non-transformed microorganism.
4. The microorganism of claim 1, said microorganism producing less CO<sub>2</sub> per unit of a product produced than does a corresponding non-transformed microorganism.
- 20 5. The microorganism of claim 1, said microorganism having a reduced oxygen requirement per unit of a product produced than has a corresponding non-transformed microorganism.
- 25 6. The microorganism of claim 1 that under the conditions of a biotechnological process maintains a higher level of the metabolic capacity required for the said process than does a corresponding non-transformed organism.
- 30 7. The microorganism of claim 6, wherein the required metabolic capacity of a corresponding non-transformed microorganism decreases with time under the conditions of the said biotechnological process.

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8. The microorganism of ~~any one of claims 1 to 7~~ <sup>claim 1</sup>, wherein the product is ethanol.
9. The microorganism of claim 8, wherein the ethanol is derived from a pentose.
- 5 10. The microorganism of claim 8, wherein the ethanol is derived from a hexose.
- a 11. The microorganism of ~~any one of claims 1 to 7~~ <sup>claim 1</sup>, wherein the product is one or more amino acids.
- 10 12. The microorganism of claim 11, wherein the amino acid is lysine.
- a 13. The microorganism of ~~any one of claims 1 to 7~~ <sup>claim 1</sup>, wherein the product is polyhydroxyalkanoate.
- 15 14. The microorganism of claim 13, wherein the polyhydroxyalkanoate is polyhydroxybutyrate.
- a 15. The microorganism of ~~any one of claims 1 to 7~~ <sup>claim 1</sup>, wherein the product is a pentitol.
- 20 16. The microorganism of claim 15, wherein the pentitol is xylitol.
- a 17. The microorganism of ~~any one of claims 1 to 16~~ <sup>claim 1</sup>, wherein at least one of the recombinant DNA molecules encodes or otherwise causes the expression of an enzyme which is a pyridine nucleotide-linked dehydrogenase.
- 25 18. The microorganism of claim 17, wherein the dehydrogenase is selected from the group consisting of glutamate dehydrogenases, malate dehydrogenases, malic enzymes and aldehyde dehydrogenases.
- a 30 19. The microorganism of ~~any one of claims 1 to 18~~ <sup>claim 1</sup>, which microorganism is a yeast.
20. The microorganism of claim 19, which microorganism is a strain of *Saccharomyces* spp., *Schizosaccharomyces* spp. or *Pichia* spp.

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21. A microorganism of claim 9, which is a strain of *Saccharomyces* spp. or *Schizosaccharomyces* spp. expressing genes encoding xylose reductase and xylitol dehydrogenase, and which is transformed with at least one recombinant DNA molecule encoding or otherwise causing the expression of an enzyme which is a pyridine nucleotide-linked dehydrogenase.
22. The microorganism of claim 21, which further expresses a gene encoding xylulokinase.
23. The microorganism of <sup>claim 1</sup> ~~any one of claims 1 to 18~~, which microorganism is a bacterium.
24. The microorganism of claim 23, which microorganism is a strain of *Corynebacteria* or *Brevibacteria*.
25. *Saccharomyces cerevisiae* strains selected from the group consisting of H1791 (VTT C-98298, DSM 12213), H1795 (VTT C-98300, DSM 12214), H1803 (VTT C-98302, DSM 12215), H2193 (VTT C-99317, DSM 12722), H2195 (VTT C-99320, DSM 12723) and H2222 (VTT C-99322, DSM 12724).
26. *Schizosaccharomyces pombe* strains selected from the group consisting of H2369 (VTT C-99323, DSM 12725) and H2370 (VTT C-99324, DSM 12726).
27. *Corynebacteria* strains selected from the group consisting of VTT E-991203 and VTT E-991204.
28. A method of producing useful products from raw materials, comprising the step of fermenting said materials with a microorganism of claim 1.
29. The method of claim 28, wherein the raw materials comprise pentoses, pentose polymers or mixtures thereof.

30. The method of claim 28, wherein the raw materials comprise hexoses, hexose polymers or mixtures thereof.

31. The method of claim 29, wherein a pentitol is produced.

32. The method of claim 31, wherein the pentitol is xylitol.

33. The method of <sup>claim 28</sup> ~~any one of claims 28 to 30~~, wherein ethanol is produced.

34. The method of <sup>claim 28</sup> ~~any one of claims 28 to 30~~, wherein one or more amino acids are produced.

35. The method of claim 34 wherein the amino acid is lysine.

36. The method of <sup>claim 28</sup> ~~any one of claims 28 to 30~~, wherein one or more polyhydroxy-alkanoates are produced.

37. The method of claim 36 wherein the polyhydroxyalkanoate is polyhydroxybutyrate.

38. A method of producing ethanol from raw materials comprising pentoses, pentose polymers or mixtures thereof, comprising the step of fermenting said materials with a microorganism of <sup>claim 19</sup> ~~any one of claims 19, 21 and 22~~.

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